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SECOND

GEOLOGICAL REPORT,

PRELIMINARY TO A FINAL REPORT.

SECOND

BIENNIAL REPORT

PRESENTED TO THE

Thirty-Second General Assembly of Tennessee,

NOVEMBER 5, 1857.

BY

JAMES M. SAFFORD,

STATE GEOLOGIST.

NASHVILLE, TENN.
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REPORT.

To the General Assembly of the State of Tennessee:

In making this my second Biennial Report, it will be my object to lay before you a brief review and statement of the nature of the Geological and Agricultural survey under my charge, and of the progress that has been made towards its completion. In doing this I will have occasion to refer to the objects of the survey, to the plans pursued, and to some of the principal results attained.

Such is the condition of the work, that it is not considered advisable, at this time, to present an extended report, or one in much detail. Should the opportunity be granted, I will be enabled, in another term, (as will be more fully explained further on,) so far to complete the survey as to present to the next General Assembly a full, digested and final report upon all that has been done, both by our former State Geologist, Dr. Troost, and by myself, towards the development and elucidation of the mineral wealth, and agricultural resources of our noble State. This will give completeness to the whole survey. Any extended and detailed posting up of results now, would be necessarily incomplete and unsatisfactory, and, besides, would be superseded by the final report, thereby involving unnecessary expense. My last report, although it does not include the discoveries and researches of the last two years, is sufficiently full to answer as an outline of our mineral resources until the final report appears, and it is my desire that it be distributed in connection with this, so far as the number of copies remaining on hand will permit. Reference will frequently be made to it.

I deem it, in view of these facts, my duty, for the present, simply to review, in general, the entire work bearing upon the points already mentioned, and giving details only so far as may be necessary to place the matter clearly and intelligibly before you.

1. THE OBJECTS AND UTILITY OF THE SURVEY.

The most important ends proposed by the Geographical survey of the State, and constantly kept in view by myself, may be classed under two heads, as follows:

First, to develop and to make known to our own people and to the world our mineral wealth; and

Secondly, to develop our agricultural resources—to examine critically our soils with reference to their improvement and greatest production.

These objects are eminently practical, and their accomplishment is of great importance to the people of the State. Of this all are convinced, and it would be superfluous to dwell upon their importance here. To know our minerals, and to make them available—to know our soils and thus to be enabled to keep up their fertility, or to improve them when defective, or to restore them when worn out, are points of great interest, the importance of which is manifest to all. But aside from the benefits resulting to our fellow-citizens as individuals, there is much for the State to gain. The accomplishment of such objects give origin to new sources of revenue, and in many cases improves the old. Moreover, the publication of our natural resources, thus developed, to the commercial world has necessarily an effect upon our credit. They show that our prosperity is not ephemeral, that our wealth has a sure basis, that we have in our fertile soils, and in the coal and iron of our hills, a guarantee of ability far more than sufficient to meet all demands against us. A systematic final report will be such a publication. State geological reports are eagerly sought after for the information of this kind they contain, and as a general thing it is to be found no where else.

There are many other considerations bearing directly upon the utility of the survey, which might be mentioned. It is, however, considered unnecessary at this time. I refer those who wish to pursue this subject, to the first chapter of my report to the last General Assembly.

2. THE PLAN PURSUED.

In carrying out the objects of the survey, it has been my first consideration to make out the geological formations* of the State, for this constitutes the foundation of the whole work. The formations are the *great storehouses*, each of which contains its own mineral *treasures;* nor need we think of easily securing these treasures, complete and entire, without a knowledge of the position and extent of their great repositories.

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* By formations I mean the different beds or strata of rocks (or, when not consolidated, of sands and clays, as in West Tennessee,) which enter into the structure of that portion of the earth accessible to us. A bed, or series of limestones, having, in the main, common characters throughout and of considerable thickness, say from a hundred to a thousand feet, is a formation. Another series of homogeneous limestones differing in color, composition, &c., from the first, is another and distinct formation. So any considerable bed of sandstone, of slate, or of granite, is in like manner a formation, as I use the term.

With reference to the agricultural portion of the survey,* a knowledge of the formations is equally necessary, for they, by disintegration or crumbling furnish the inorganic materials of the soils, and hence, in great part, determine their nature. Hence we have "limestone soils," "sandstone soils," slate soils," &c. The connection is even more intimate than this: the soil of limestone, for instance, varies with the impurities of the limestone, and may be red or yellow, sandy or argillaceous, mellow or stiff, according to these impurities. It is to these formations, then, that we must first look. A general agricultural survey on any other basis would be, in fact, impracticable. But with the formations made out, and the areas which they severally contribute to the surface of the State mapped off, we would find our agricultural survey well advanced, and would have already a map of the soils. The State would thus be divided into natural agricultural districts, each with its own general soil, about which much would be already known. The number of districts, differing in kind, would be comparatively small, not more, perhaps, than twenty, some of them including, wholly or in part, from six to a dozen counties. Each district would be a unit in itself, having throughout the same general agricultural capacities and defects, suited to the same crops, requiring the same treatment, the same manure, etc., etc. A series of analyses and experiments could be instituted which would be peculiarly applicable to each district, to its common soil, and to all the local modifications thereof produced by physical causes, or by long and unskilful culture. The work done in one county would apply generally to the other counties of the same district, and thus, in many cases, a useless repetition of expensive work would be avoided. The survey then would reduce itself to the thorough examination of about twenty kinds, or fundamental varieties of soil, including the study of all the modifications that each undergoes, or has undergone, through the influence of natural causes, or by culture. The soil of a district being well understood, it will not be difficult, by a few well-applied analyses, to ascertain the essential materials that have been removed by the too constant cultivation of corn, wheat, cotton, or any other agricultural product; it will not be difficult, under these circumstances, to tell the farmer what his "old field" must receive in order to be restored to its native fertility, &c., &c.

It is easy to see how greatly this mode of proceeding would facilitate and shorten the work. It gives it too, a definiteness not attainable in any other way.

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* Much of what is said in this report with reference to agriculture, and my general plan, was also communicated to the Agricultural Bureau a few weeks since. My views met with their unanimous approval.

With reference, then, to the agricultural interests, as well as the mineral, and in accordance with the above views, my plan has been to make out, first, the formations, to find out their characters, compositions, difference, etc.; to trace out their limits; to ascertain what portion of the surface of the State each one forms; to represent them accurately upon a map of suitable size, etc. Following this work, and, as far as possible, in connection with it, I have aimed, in the second place, to bring out the practical results—that is to develop and elucidate, on the one hand, the useful mineral contents or products, and, on the other, the agricultural resources of each formation.

From this plan nothing has been permitted to divert me. In the prosecution of the work *every county* has been examined, to a greater or less extent, and most of them have been visited three or four times, requiring more than ten thousand miles of traveling and involving much severe labor. In a word, the survey—in which I have felt and feel no little pride, and which I desire to see brought to a satisfactory termination—has been pushed to the utmost (and even beyond the utmost,) justified by the means placed at my disposal by the State.

3. WHAT HAS BEEN ACCOMPLISHED, AND WHAT REMAINS TO BE DONE.

It affords me satisfaction to be able to say that the groundwork of the survey is sufficiently complete. The formations have all been made out, or, at least, so nearly so that there remain but very few doubtful points to be settled, and which, in no way can interfere with the speedy completion of the survey. Two years ago I presented a map of the formations to the Legislature. Some portions of that map were provisional especially with reference to West Tennessee. I will now be able to perfect it. Its value will be the more appreciated, when it is recollected that it will be truly an agricultural map: of this, however, we will speak urther on.

Much labor has been expended upon the development of the minerals of the State, and but a few months more will be required o place this portion of the work in a proper position to be reported upon fully. Most of the material is already complete.

In my report of 1855–6, I gave a sketch of our mineral resources. This, although incomplete, will give some idea of what had been done up to that time. My researches since have been greatly xtended and with more success, than my brightest anticipations oked for. The only proper place now, however, in accordance ith reasons already given, for a full presentation of the results rrived at, is in a final report. I will, however, by way of illustrang the nature of these results refer to one or two examples.

When it is recollected that the value of the iron produced already n Tennessee is about $2,000,000 yearly, it can be easily understood that the development of a wholly unoccupied and neglected iron field, which is capable of adding a half more to the production, is a very important and very gratifying result. I have, in my former report, spoken of our three producing iron regions, and have given names to them. They are as follows:

First, *The Eastern*, in East Tennessee, which runs through the State, lying along and in front of the Unaka group of mountains. Many of its banks occur in the coves and valleys included in the mountain ridges:

Secondly, *The "Dyestone" Region*, also in East Tennessee. This skirts the eastern base of the Cumberland and Walden's Ridge from Virginia to Georgia. The Sequatchee and Elk valleys are included:

Thirdly, *The Western Region*, occupying a wide strip of the western part of Middle Tennessee, and a portion of the District. This extensive field runs from out of Kentucky to the Alabama line.

To these I will have the pleasure of adding a *fourth*, the ores of which have been comparatively unknown and unnoticed. There is not a furnace, bloomery or forge working them; neither are similar iron ores worked or known as such by our iron men any where in Tennessee. This field, lying both in Middle and in East Tennessee, is nearly co-extensive with the Cumberland table-land and of course with the coal region. We have in it the iron ore and the coal in juxta-position—a most happy union for the producer. There are two varieties of ore occurring, the one the "*clay iron stone*" and the other so called "*black band*," in the reduction of both of which stone coal can be used. The ores are found at many points in abundance. During the last summer, interesting discoveries have been made, all of which I desire to report upon in due time. The importance of this iron-field can hardly be over estimated. I add a few extracts from good authority showing the value of these ores.

Whitney, in his "Metallic Wealth of the United States," says: "It is to the abundance of her coal-measure iron-stones that England is indebted for her vastly preponderating production of this metal; and it is thus that she has been able to supply the rapidly increasing demand for railway iron, which the discovery of a new means of national intercommunication rendered necessary. The coal-fields of North and South Wales, North and South Staffordshire, etc., while they furnished the fuel to smelt the ore, furnished the ore itself, and the necessary flux from the same shaft, with hardly any increased expense beyond what it would have cost to raise the coal alone."

Again, the following remarkable instance is in point and illustrates the value of one of our ores mentioned above. "Between thirty and forty years ago, a family of the name of Baird owned a small farm of some thirty or forty acres, between seven or eight miles from Glasgow. This property was underlaid by a bed of coal which was worked to a very limited extent by the proprietors, and hauled by single cart-loads to the Glasgow market. Partly from this small business, and partly from the products of the farm, the family barely made a living, finding it often difficult to make the two ends meet.*

"During the excavations for the coal on the farm, a kind of ironstone had been encountered, and considerable quantities taken out, which lay scattered in piles at the mouth of the pit, as worthless rubbish encumbering the ground. At one of their family meetings, while counciling in regard to future prospects, it was suggested by the eldest son that perhaps they might be able to make iron profitably from some of these waste ironstones. The father, supposing the amount of capital required to commence such a business entirely beyond their limited means, thought, at first, such an enterprise out of the question. Finally, however, by uniting the whole savings of the family, and by effecting certain small loans, the father and sons managed to erect, with the sum of £1200, an iron furnace for the production of pig iron from their *black-band* ironstone and coal.

"The business succeeded beyond their expectations; in a few years they were not only able to pay off the borrowed capital, but had laid up a surplus sufficient to erect another furnace. Soon they were able to purchase adjoining coal and iron property, and lease the mining right for black-band ore on other estates. The real value of the ore being, as yet, but little appreciated they were enabled to obtain mining rights for it at a shilling a ton, while some of their neighbors in the same business, starting later in this branch of the trade, paid 15, 16, and even as high, in some instances as 18 shillings per ton. Progressing in the business under such favorable auspices, wealth flowed in fast, and they were enabled to extend their business rapidly. Ultimately, on their well known estate of Gartsberry, celebrated throughout Scotland, there were sixteen furnaces in blast, besides three or four more in Ayrshire.

"That Baird family are now in the annual receipt, from their coal and iron works, of a clear profit of half a million of pounds sterling, or two and a half million of dollars, wielding a monied influence beyond even the princes of the land. And let it be forcibly impressed on the minds of my readers that this immense wealth was not amassed by speculation, but by legitimate earnings from a business producing an article of the greatest intrinsic value and giving, at the same time, constant employment to whole towns of industrious inhabitants."

From these examples the value of our coal-measure ironstones, heretofore overlooked, may be inferred. In connection with the coal its value is rather to be estimated by millions than by thousands. In my final report—should such be published—it will be my privilege and pleasure to present its resources in bright and yet faithful colors.

I might here dwell upon the developments made with reference to our stone coal. A reconnoisance has been made of the whole field which has an area of 4400 square miles. In addition to this, examinations in detail have been made to great extent, putting it in my power very soon to complete this portion of the work. As to results, let it suffice for the present to say that they are most satisfactory, and that the amount of coal in Tennessee will be shown to be considerably greater than the amount specified in my report of 1855, where it is stated to be at least equal in volume to "a solid block of coal eight feet high, twenty miles wide, and two hundred and twenty miles long." This amount seems enormous, but nevertheless it will be shown to be below the truth.

Especial attention has been devoted to the *green sand* or *marl* of West Tennessee. This substance is a native fertilizer and is destined to be of vast importance to the farmers of the District. In New Jersey the very same marl has been used extensively, and there it is thus spoken of: "It has been worth millions of dollars to the State in the increased value of the land and produce, besides the influence it has exerted in awakening and fostering a spirit for agricultural improvement." Again, the value of land affording this marl, simply as an article of traffic, is thus set forth: "Pits ten feet square, and as deep as the purchaser chooses to dig them, are sold for from five to seven dollars. An acre contains more than four hundred and thirty-five such pits, worth at least $2,175." (See further the report of 1855.)

Within the last year it has been my good fortune to discover beds of this substance before unknown, and of superior quality. I have found that there are two distinct ranges of it—one of which in Hardeman county was unknown. The marls of the two ranges differ considerably in geographical position. The main range has been thoroughly traced out through McNairy, the western part of Hardin, and as far north as Beech river in Henderson, where I found it to be ten miles wide. It doubtless runs northward into other counties, and will prove to be seventy or eighty miles long. At some points the thickness of the stratum is three hundred feet, so that the quantity, within the limits of Tennessee, is exceedingly great. It will require but a few weeks to ascertain its northern limit, which will complete the field work to be done upon it.

I have made it an object, everywhere in the marl region, to call the attention of farmers to its great value as a manure. Many have already commenced experimenting upon it, and with gratifying results. Its value will soon be generally appreciated. In a final report it will be an object to give all facts bearing upon its practical utility, and specific directions for its use.

These are some of the results attained, and about to be attained in the progress of the survey, and thus we might speak, were it necessary, of the other mineral and geographical resources of East, Middle and West Tennessee.

With reference to our agricultural resources—the portion of the survey to which all else is now subordinate—much has already been done. From the first, the agricultural interests have always been kept in view, and in fact, as has been stated, the very same preliminary work required in the development of our minerals is required in the development of the resources of our soils. The making out of the formations is the ground work and the key to the whole matter. How this makes an agricultural survey practicable and easy, has been already explained. By what has been accomplished, the agricultural survey is indeed half done. The different soils—products as they are of the different formations—each constituting an agricultural district with its own specific characters—have been carefully and almost entirely traced out. In addition much has been ascertained in regard to the nature and the adaptations of each, and they are all placed in such a condition as to make further examinations direct and effectual. The agricultural map, of which we have spoken, will lay the whole subject of the soils clearly before those who are interested—and who is not ?—in their improvement and greatest production. This and that soil can be discussed—its fertility—to what best adapted—its defects and how to remedy them, &c., &c.

The number of agricultural districts differing in kinds is, as we have before stated, about twenty. I will mention a few of them by way of illustration. The Mississippi river bottoms, embracing in Tennessee an area of about eight hundred square miles, constitute a well defined and well characterized one. Another is formed by a remarkable formation—the "ashen loam" of Memphis ; this occupies a strip of the State about thirty miles wide, lying adjacent to the bottoms mentioned, and running from Shelby to Obion through the State. There are three others as interesting and well defined as West Tennessee. In Middle Tennessee, the central and rich blue limestone basin is a good example. The last is completely surrounded by an interesting and nearly homogeneous rim or circle of lands more or less elevated, which is another. The wide and elevated plains of the Cumberland Mountain or table-land is another unique and well marked district, with an area of more than four thousand square miles. In East Tennessee we have the greatest number of districts—a consequence of her geographical structure. Here they often take the form of long and beautiful valleys, of which Powell's Valley, Sequatchee Valley, the New Market and Sweet Water Valleys, are examples. There are besides these many others quite as beautiful. Many of them are alike in kind, and will be classed together.

Such are some of the examples of our agricultural districts. I have done nothing more than simply to refer to them. In addition to what has been said, reference to a colored copy of my geographical map may be made.

Hereafter I hope to be able to present the limits, features, and other characters of these districts, so far as they bear upon agriculture, complete and entire. Materials to a considerable amount are already at hand. What remains to be done is to carry out the investigation of the soils, in accordance with the plan already mentioned.

Finally, should the General Assembly see fit to continue me in the office I now hold for another term, I will be able, as has been before stated, to write out a final report, which I desire to do, upon all my labors—presenting the results in a systematic, digested form, so that, in any event, after the expiration of the term, they will not be lost to the State. Should this be done, about nine months of the next term will be devoted to work in the field, completing the unfinished parts, and more especially collecting soils for analysis. The remaining fifteen months will be given to close analytical work in my laboratory, and to the preparation of my report, which I shall aim to make wholly practical, and in every way suited to those whom I serve—my fellow-citizens of Tennessee.

J. M. SAFFORD,
State Geologist of Tennessee.

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